MULTIMEDIA UNIVERSITY TM

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2015/2016

EEL3036 – POWER SYSTEMS ANALYSIS

(LE)

13 OCTOBER 2015
2.30 p.m – 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 pages including the cover page with 4 Questions only.

2. Answer **ALL** questions. The distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) List out TWO advantages of per unit calculations in the power systems. [4 Marks]

(b) A single line diagram of a power system is shown in Figure Q1. Per unit reactance values on a common 100 MVA base are indicated in the figure. The ratings of various components are listed below. Choose a base of 100 MVA and 33 kV on G_1. Obtain the following:

(i) Impedance diagram for the power systems in Figure Q1 (without the values). [5 Marks]

(ii) The new per unit impedance values for these components in the figure: X_{T1}, X_{TL1}, X_{G2}, X_{TL2}, X_{T4} and X_M. [16 Marks]

G_1: 100 MVA, 33 kV, X=0.2 pu
G_2: 100 MVA, 130 kV, X=0.1 pu
M : 10 MVA, 10 kV, X=0.1 pu
T_1 : 100 MVA, 135 kV/33 kV, X=0.25 pu
T_2 : 100 MVA, 135 kV/33 kV, X=0.5 pu
T_3 : 25 MVA, 13.2kV/150kV, X=0.5 pu
T_4 : 25 MVA, 13.2kV/150kV, X=0.5 pu

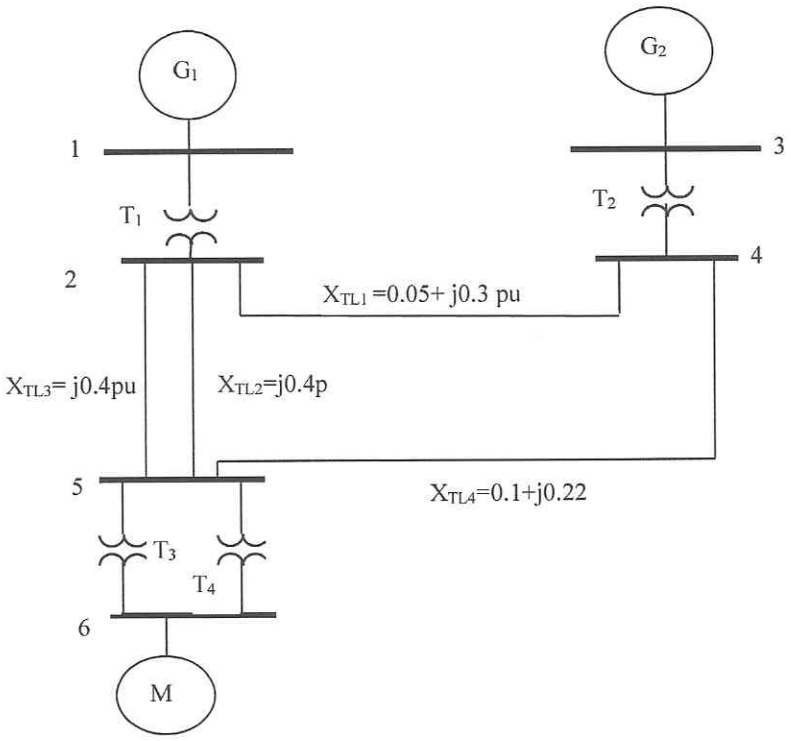

Figure Q1

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Question 2

The bus admittance matrix and the bus data corresponding to a 4-bus network are given below.

$$Y_{bus} = \begin{bmatrix} -j5 & j2 & j3 & 0 \\ j2 & -j4 & 0 & j2 \\ j3 & 0 & -j4 & j1 \\ 0 & j2 & j1 & -j3 \end{bmatrix}$$

Bus No	Generation		Load			
	P, per unit	Q, per unit	P, per unit	Q, per unit	V, per unit	Remarks
1	-	-	0	0	$1.05\angle 0^0$	Slack Bus
2	1	-	0.80	0.75	$1.04\angle 0^0$	PV Bus
3	0	0	0.50	1.50	$1.00\angle 0^0$	Load Bus
4	0	0	0.50	0.50	$1.00\angle 0^0$	Load Bus

Assume that all the angle corrections $\Delta\delta_2$, $\Delta\delta_3$ and $\Delta\delta_4$ are zero degree. Obtain the following:

(a) The $Q_2^{(1)}$ is calculated as 0.0624. Determine the voltage at bus 2 at the end of the first iteration of the Gauss-Seidel method of power-flow analysis. [5 Marks]

(b) In order to carry out power flow study of the system using the Newton-Raphson method, calculate the forth row and forth column of the Jacobian. [5 Marks]

(c) Matrix $\overline{B}$ for use in the decoupled power flow method. [3 Marks]

(d) The reactive mismatches; $\frac{\Delta Q_3}{|V_3|}$ and $\frac{\Delta Q_4}{|V_4|}$ [8 Marks]

(e) The voltage magnitude, $|V_3|$ at the end of the first-iteration using the decoupled form of the Newton-Raphson method. [4 Marks]

Continued...

Question 3

A transmission system consists of three alternators, three transformers and a transmission line is connected as shown in Figure Q3. The parameters of the various components are given in Table Q3.

The open-circuit voltage of all the alternators is 1.5 p.u. The star points of the alternators are solidly earthed while those of the transformers are earthed through a reactance of 0.4 p. u. Assuming that there is no infeed to or from Bus 2 and that all given p.u values are on the same base, find the following:

(a) Sketch the symmetrical component networks applicable to the investigation of unbalanced faults occurring at Bus 1 of the system. Find the equivalent impedance for each network. [9 Marks]

(b) For a double-line to earth fault involving the Yellow and Blue phases at Bus 1:
- (i) Sketch the symmetrical-component networks that must be connected to define the relationship between the symmetrical-components of voltage and current at Bus 1. [3 Marks]
- (ii) Calculate the currents in the two faulty phases. [11 Marks]
- (iii) Calculate the value of the fault current fed into the earth. [2 Marks]

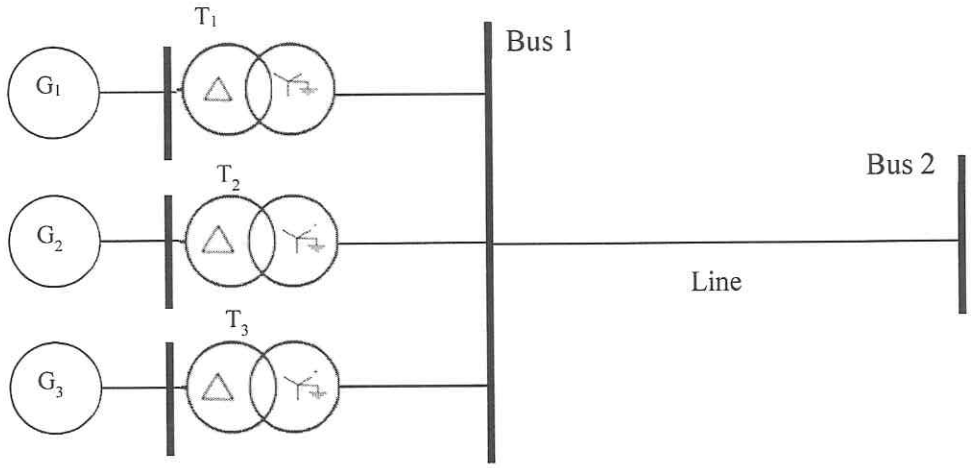

Figure Q3

Table Q3

	Positive sequence reactance X_1 (p.u)	Negative sequence reactance X_2 (p.u)	Zero sequence reactance X_0 (p.u)
Alternators G_1, G_2 and G_3	0.15	0.35	0.15
Transformers X_1, X_2 and X_3	0.15	0.25	0.15
Transmission Line	0.14	0.14	0.3

Continued...

Question 4

(a) The complexity of the numerical computation increases as the number of machines increases. In order to reduce this numerical complexity, some simplifying assumptions have to be made. Briefly explain FOUR assumptions to obtain calculations for multimachine power system stability. [10 Marks]

(b) A multimachine power system shown in Fig. Q4 has two generators and three transmission lines. The reactance of each line and transient reactances of the generators in p.u. are marked in the figure. A three-phase fault occurs at bus 3. The prefault bus voltages are: $V_1=1.05\angle 0$, $V_2=1.0\angle 0.038^o$ and $V_3=0.979\angle -5.78^o$. Determine the following which are required to perform transient stability analysis of the given multimachine power system.

(i) Bus admittance matrix for the network (for power flow-analysis) [3 Marks]

(ii) Prefault augmented bus admittance matrix. [7 Marks]

(iii) During-fault augmented bus admittance matrix. [2 Marks]

(iv) During-fault reduced bus admittance matrix. [3 Marks]

(Hint: $Y_{bus}^{red}=[Y_{mm}-Y_{nm}^{t}Y_{nn}^{-1}Y_{nm}]$)

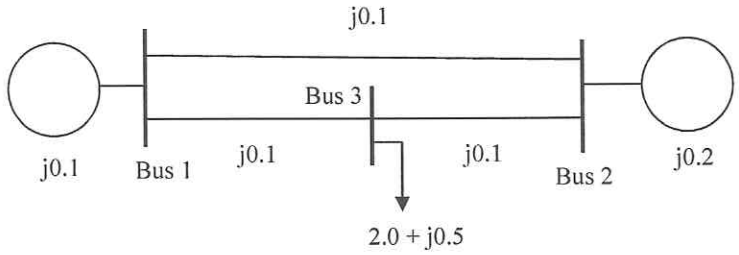

Figure Q4

End of Paper.